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VORTEX DYNAMICS AND VORTEX BREAKDOWN

12. PERSONAL AUTHOR(S)

Dr. Melvyn S. Berger

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The determination of large section cross section vortex rings and bubbles with swirl. I have been able to determine analytically vortex rings and bubbles with swirl via the Stokes stream-function from an isoperimetric variational viewpoint extending my previous work. Leapfrogging of Vortex Rings. In the case of thin vortex rings I have been able to establish analytically the Hamiltonian formulation and the calculus of variations.

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August 16, 1988

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Professor M. S. Berger

M S Berger

Technical Report for Grant NO AFOSR-87-~~0710~~ 0170

A. Scientific Progress Achieved

I. The determination of large cross section vortex rings and bubbles with swirl. I have been able to determine analytically vortex rings and bubbles with swirl via the Stokes stream-function from an isoperimetric variational viewpoint extending my previous work. I have begun (with a postdoctoral student) implementing my approach numerically.

II. Vortex Breakdown and Bifurcation. I have been able to utilize my ideas in (I) above to study bubble-type (B type) vortex breakdown in terms of bifurcation between axisymmetric sub-critical and supercritical equilibria.

III. Leapfrogging of Vortex Rings. In the case of thin vortex rings I have been able to establish analytically the Hamiltonian formulation and the calculus of variations (large amplitude study of strictly periodic relative motion of (thin) vortex rings) (joint work with a Ph.D. student).

IV. A New Type of Bifurcation for Time-Dependent Partial Differential Equations with Periodic Forcing. I discovered a type of bifurcation for nonlinear parabolic systems of p.d.e. (like the Navier-Stokes equations) periodic forcing differing substantially

from Hopf bifurcation.

B. Talks Given

1. April 1987 American Mathematical Society
"Vortex Breakdown and Bifurcation" Newark NJ NJIT

2. June 1987 Invited Colloquia Institute of Scientific Study
"A New Type of Bifurcation" Bures Sur Yvette

3. May 1987 University of Paris Colloquium Talk
"Vortex Dynamics"

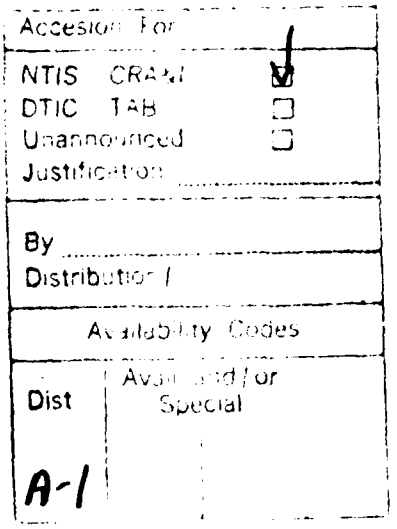
4. August 1987 Nonlinear Dynamics Conference Washington DC
"Vortex Motions in Fluids"

5. November 1987 American Physical Society Annual Meeting
"Axisymmetric Vortex Rings and Bubbles with Swirl" Eugene Oregon

C. Additional Conferences Attended

1. July 1987 Federal Conference on Super Conductivity
Washington DC

2. August 1987 Wood's Hole Program on Fluid Dynamics



D. Research Publications

(i) Super-conducting vortices for the Ginzberg Landau equations, to appear Journal of Function Analysis Nov. 1988 (66 page manuscript)

(ii) Axisymmetric Swirling Motion for Ideal Fluids, Contemporary math vol. 72 p. 27-32

(iii) Bifurcation from Equilibrium for Forced Nonlinear Evolution equations (to appear) Bulletin Amer. Math. Soc.

(iv) Remarks on Vortex Breakdown (to appear) Conference on Vortex Dynamics AMS-SIAM

(v) Vortex Rings with Swirl via the Streamfunction (in preparation)

(vi) Leapfrogging Interaction of Vortex Rings in an Ideal Fluid (in preparation).

(vii) Helical Vortex Breakdown (to appear)

(viii) Vortices in High Tc Superconductivity - A Historical Perspective (to appear in volume Advances in Superconductivity 1988 Elsevier Publishers)

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No research was relevant to patents.